ISO TC 4 SC 1 (Sweden 12) 40 E
ISO TC 4 (Secretariat 17) 56 E
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ISO TC 4

BALL AND ROLLER BEARINGS

Sub Committee 1

SWEDISH PROPOSALS
JANUARY 1953

SIS

Sveriges Standardiseringskommission

Stockholm

Sweden

ISO TC 4 SC 1 (Sweden 12) 40
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1. Footnote on Application of Chamfers

ISO TC 4 (Secretariat 13) 36 January 1952. Chapter II, Section 1, Table 1,3 (page 7)

TC Resolution 17 (6 New York 1952)

Sweden proposes the footnote on application of chamfers to read as indicated under section 2, table 2,1 below.

2. Chamfer Dimensions

ISO TC 4 (Secretariat) 1, February 1949, Section 611 (page 24) and Appendix 6,1

ISO TC 4 (Secretariat) 4, June 1949, Section 611 (page 7 and 8)

ISO TC 4 (Secretariat 13) 36, January 1952, Chapter II, Section 1. Table 1,3 (pages 6 and 7)

ISO TC 4 SC 1 (Sweden 11) 33, January 1952, Section 3 A (page 5)

TC Resolution 18 (7 New York 1952)

The General Plan as proposed by SC 1 contains nominal chamfer dimensions. The American version of the plan gives smaller chamfer dimensions, explained by the footnote: "The corner radius or chamfer on bearings must clear the maximum fillet radius given in the table. This specification does not control bearing corner contours."

In reality there is no contradiction between these two methods of presentation as the manufacturers, basing their catalogues on the SC 1 proposal, as a rule inform their customers separately about the permissible maximum shaft fillet radius.

With one single exception the maximum fillet radius has been the same for the same bearing dimension in all cases. The exception is found in dimension series 19-69, bore 3 mm, where the maximum fillet is 0,1 mm according to American practice and 0,15 mm according to ISO TC 4 (Secretariat) 4, June 1949, section 611 (page 8).

Sweden considers the publication of the permissible maximum fillet radius to be a valuable information for the customers, but considers the permissible minimum shoulder height to be equally important. Sweden also considers it to be misleading only to give the maximum fillet but not the minimum shoulder height at the same time.

The way out of the difficulty seems to be the introduction of both values in the general plan or a separate table giving the chamfer dimensions of all the bearings of the general plan. For the convenience of the manufacturers who want to save space in their printed matter a table could be made up indicating the conventional nominal chamfer corresponding to the pairs of maximum and minimum values appearing in the general plan.

Sweden proposes the chamfer dimensions given in table 2,1 below to be considered as part of the general plan. This table applies to bores of 3 mm and upwards, including the larger bearing dimensions proposed in section 3 below. A graphical representation of the proposed values clearly shows that the relation between bore and chamfer dimensions as well as the chamfer tolerances is a satisfactorily continuous function. To achieve this it has been necessary to decrease some of the maximum values earlier proposed. The equalization of the maximum value curves has been made in this way in order to avoid unnecessarily great shoulder heights.

Table 2,1 is completed by three footnotes. Footnote 1 concerns the application of chamfers dealt with in section 1 above. The footnotes 2 and 3 are intended to give a bearing user the necessary information about permissible shaft design and the bearing manufacturer an indication of the importance of keeping the chamfer dimensions well within the indicated tolerances.

Table 2,2 gives the nominal chamfers corresponding to the dimensions appearing in table 2,1. An irregularity exists as 0,5 mm nominal chamfer is indicated for two pairs of limits. The Chamfer 0,5 mm is a very old dimension used for comparatively small bearings. A closer study of the relation between the bearing bore and the minimum shoulder height shows that 1 mm shoulder height is rather much for the smallest bearings using 0,5 mm nominal chamfer. This is the technical reason why this irregularity has been permitted.

CHAMFERS ON RADIAL BEARINGS

Bore d mm	Dimension Series 08 min	08 max	18-68 min	18-68 max	09 min	09 max	19-69 min	19-69 max	00 min	00 max	10-60 min	10-60 max	01 min	01 max	11-41 min	11-41 max	82 min	82 max	02-42 min	02-42 max	83 min	83 max	03-33 min	03-33 max	04-24 min	04-24 max
3	-	-	0,1	0,3	-	-	0,15	0,4	-	-	0,2	0,5	-	-	-	-	0,1	0,3	0,2	0,5	-	-	0,3	0,8	-	-
4	-	-	0,1	0,3	-	-	0,2	0,5	-	-	0,2	0,5	-	-	-	-	0,2	0,5	0,2	0,6	-	-	0,3	0,8	-	-
5	-	-	0,2	0,5	-	-	0,2	0,5	-	-	0,2	0,5	-	-	-	-	0,2	0,5	0,3	0,8	-	-	0,3	1	-	-
6	-	-	0,2	0,5	-	-	0,2	0,5	-	-	0,3	0,8	-	-	-	-	0,2	0,6	0,3	0,8	-	-	0,3	1	-	-
7	-	-	0,2	0,5	-	-	0,3	0,8	-	-	0,3	0,8	-	-	-	-	0,3	0,8	0,3	1	-	-	0,3	1	-	-
8	-	-	0,2	0,6	-	-	0,3	0,8	-	-	0,3	0,8	-	-	-	-	0,3	0,8	0,3	1	-	-	0,3	1	0,6	1,5
9	-	-	0,2	0,6	-	-	0,3	0,8	-	-	0,3	0,8	-	-	-	-	0,3	0,8	0,6	1,5	-	-	0,6	1,5	0,6	1,5
10	-	-	0,3	0,8	-	-	0,3	0,8	-	-	0,3	1	-	-	-	-	0,3	0,8	0,6	1,5	0,3	1	0,6	1,5	0,6	1,5
12	-	-	0,3	0,8	-	-	0,3	0,8	0,3	0,8	0,3	1	-	-	-	-	0,3	1	0,6	1,5	0,3	1	1	2,2	1	2,2
15	-	-	0,3	0,8	-	-	0,3	0,8	0,3	0,8	0,3	1	-	-	-	-	0,3	1	0,6	1,5	0,3	1	1	2,2	1	2,7
17	-	-	0,3	0,8	-	-	0,3	1	0,3	0,8	0,3	1	-	-	-	-	0,3	1	0,6	1,5	0,6	1,5	1	2,2	1	2,7
20	0,3	0,8	0,3	0,8	0,3	0,8	0,3	1	0,3	0,8	0,6	1,5	-	-	-	-	0,3	1	1	2,2	0,6	1,5	1	2,7	1	2,7
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,3	1	1	2,2	0,6	1,5	1	2,7	-	-
25	0,3	0,8	0,3	0,8	0,3	0,8	0,3	1	0,3	1	0,6	1,5	-	-	-	-	0,3	1	1	2,2	0,6	1,5	1	2,7	1,5	3,5
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,6	1,5	1	2,2	0,6	1,5	1	2,7	-	-
30	0,3	0,8	0,3	1	0,3	0,8	0,3	1	0,3	1	1	2,2	-	-	-	-	0,6	1,5	1	2,2	0,6	1,5	1	2,7	1,5	3,5
32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,6	1,5	1	2,2	0,6	1,5	1	2,7	-	-
35	0,3	0,8	0,3	1	0,3	0,8	0,6	1,5	0,3	1	1	2,2	-	-	-	-	0,6	1,5	1	2,7	0,6	1,5	1,5	3,5	1,5	3,5
40	0,3	0,8	0,3	1	0,3	1	0,6	1,5	0,3	1	1	2,2	-	-	-	-	0,6	1,5	1	2,7	1	2,2	1,5	3,5	2	4
45	0,3	0,8	0,3	1	0,3	1	0,6	1,5	0,6	1,5	1	2,2	-	-	-	-	0,6	1,5	1	2,7	1	2,2	1,5	3,5	2	4
50	0,3	1	0,3	1	0,3	1	0,6	1,5	0,6	1,5	1	2,2	-	-	-	-	0,6	1,5	1	2,7	1	2,2	2	4	2	4,5
55	0,3	1	0,3	1	0,3	1	1	2,2	0,6	1,5	1	2,7	-	-	-	-	0,6	1,5	1,5	3,5	1	2,7	2	4	2	4,5
60	0,3	1	0,3	1	0,3	1	1	2,2	0,6	1,5	1	2,7	-	-	-	-	1	2,2	1,5	3,5	1	2,7	2	4,5	2	4,5
65	0,3	1	0,6	1,5	0,3	1	1	2,2	0,6	1,5	1	2,7	-	-	-	-	1	2,2	1,5	3,5	1	2,7	2	4,5	2	4,5
70	0,3	1	0,6	1,5	0,6	1,5	1	2,2	0,6	1,5	1	2,7	-	-	-	-	1	2,2	1,5	3,5	1,5	3,5	2	4,5	2,5	5,5
75	0,3	1	0,6	1,5	0,6	1,5	1	2,2	0,6	1,5	1	2,7	-	-	-	-	1	2,2	1,5	3,5	1,5	3,5	2	4,5	2,5	5,5
80	0,3	1	0,6	1,5	0,6	1,5	1	2,2	0,6	1,5	1	2,7	-	-	-	-	1	2,2	2	4	1,5	3,5	2	4,5	2,5	5,5
85	0,3	1	1	2,2	0,6	1,5	1	2,7	0,6	1,5	1	2,7	-	-	-	-	1	2,7	2	4	2	4	2,5	5,5	3	7
90	0,3	1	1	2,2	0,6	1,5	1	2,7	1	2,2	1,5	3,5	-	-	-	-	1	2,7	2	4	2	4	2,5	5,5	3	7
95	0,3	1	1	2,2	0,6	1,5	1	2,7	1	2,2	1,5	3,5	-	-	-	-	1	2,7	2	4,5	2	4	2,5	5,5	3	7
100	0,3	1	1	2,2	0,6	1,5	1	2,7	1	2,2	1,5	3,5	1	2,7	2	4	1,5	3,5	2	4,5	2	4,5	2,5	5,5	3	7
105	0,3	1	1	2,2	0,6	1,5	1	2,7	1	2,2	2	4	1	2,7	2	4	1,5	3,5	2	4,5	2	4,5	2,5	5,5	3	7
110	0,6	1,5	1	2,2	0,6	1,5	1	2,7	1	2,2	2	4	1	2,7	2	4	1,5	3,5	2	4,5	2,5	5,5	2,5	5,5	3	7
120	0,6	1,5	1	2,2	0,6	1,5	1	2,7	1	2,2	2	4	1,5	3,5	2	4	-	-	2	4,5	2,5	5,5	2,5	5,5	4	9
130	0,6	1,5	1	2,7	1	2,2	1,5	3,5	1	2,7	2	4	1,5	3,5	2	4	-	-	2,5	5,5	2,5	5,5	3	7	4	9
140	0,6	1,5	1	2,7	1	2,2	1,5	3,5	1	2,7	2	4	1,5	3,5	2	4,5	-	-	2,5	5,5	3	7	3	7	4	9
150	0,6	1,5	1	2,7	1	2,2	2	4	1	2,7	2	4,5	2	4	2	4,5	-	-	2,5	5,5	-	-	3	7	4	9
160	0,6	1,5	1	2,7	1	2,2	2	4	1,5	3,5	2	4,5	2	4	2	4,5	-	-	2,5	5,5	-	-	3	7	4	9
170	0,6	1,5	1	2,7	1	2,2	2	4	1,5	3,5	2	4,5	2	4	2	4,5	-	-	3	7	-	-	3	7	4	9
180	0,6	1,5	1	2,7	1	2,7	2	4	2	4	2	4,5	2	4,5	2,5	5,5	-	-	3	7	-	-	3	7	5	11
190	1	2,2	1,5	3,5	1	2,7	2	4	2	4	2	4,5	2,5	5,5	2,5	5,5	-	-	3	7	-	-	4	9	5	11
200	1	2,2	1,5	3,5	1,5	3,5	2	4,5	2	4	2	4,5	2,5	5,5	2,5	5,5	-	-	3	7	-	-	4	9	5	11
220	1	2,2	1,5	3,5	1,5	3,5	2	4,5	2	4,5	2,5	5,5	2,5	5,5	3	7	-	-	3	7	-	-	4	9	5	11
240	1	2,2	2	4	1,5	3,5	2	4,5	2	4,5	2,5	5,5	3	7	3	7	-	-	3	7	-	-	4	9	5	11
260	1	2,2	2	4	2	4	2	4,5	2,5	5,5	3	7	3	7	3	7	-	-	4	9	-	-	5	11	6	14
280	1	2,7	2	4	2	4	2	4,5	2,5	5,5	3	7	3	7	4	9	-	-	4	9	-	-	5	11	6	14
300	1,5	3,5	2	4,5	2	4,5	2,5	5,5	3	7	3	7	4	9	4	9	-	-	4	9	-	-	6	14	6	14
320	1,5	3,5	2	4,5	2	4,5	2,5	5,5	3	7	3	7	4	9	4	9	-	-	4	9	-	-	6	14	7	17
340	1,5	3,5	2	4,5	2	4,5	2,5	5,5	3	7	4	9	4	9	4	9	-	-	5	11	-	-	6	14	7	17
360	1,5	3,5	2	4,5	2	4,5	2,5	5,5	3	7	4	9	4	9	4	9	-	-	5	11	-	-	6	14	7	17
380	2	4	2	4,5	2,5	5,5	3	7	3	7	4	9	4	9	4	9	-	-	5	11	-	-	6	14	7	17
400	2	4	2	4,5	2,5	5,5	3	7	4	9	4	9	5	11	5	11	-	-	5	11	-	-	6	14	9	21
420	2	4	2	4,5	2,5	5,5	3	7	4	9	4	9	5	11	5	11	-	-	6	14	-	-	7	17	9	21
440	2	4	2	4,5	3	7	3	7	4	9	5	11	5	11	5	11	-	-	6	14	-	-	7	17	9	21
460	2	4,5	2,5	5,5	3	7	3	7	4	9	5	11	5	11	6	14	-	-	6	14	-	-	7	17	9	21
480	2	4,5	2,5	5,5	3	7	4	9	4	9	5	11	5	11	6	14	-	-	6	14	-	-	7	17	11	25
500	2	4,5	2,5	5,5	3	7	4	9	4	9	5	11	6	14	6	14	-	-	6	14	-	-	9	21	11	25
530	2	4,5	2,5	5,5	3	7	4	9	5	11	5	11	6	14	6	14	-	-	7	17	-	-	9	21	11	25
560	2	4,5	2,5	5,5	4	9	4	9	5	11	5	11	6	14	6	14	-	-	7	17	-	-	9	21	11	25
600	2,5	5,5	2,5	5,5	4	9	4	9	5	11	5	11	6	14	6	14	-	-	7	17	-	-	11	25	11	25
630	2,5	5,5	3	7	4	9	5	11	5	11	6	14	6	14	6	14	-	-	9	21	-	-	11	25	11	25
670	2,5	5,5	3	7	4	9	5	11	5	11	6	14	6	14	6	14	-	-	9	21	-	-	11	25	11	25
710	3	7	3	7	4	9	5	11	5	11	6	14	7	17	7	17	-	-	9	21	-	-	11	25	-	-
750	3	7	4	9	5	11	5	11	6	14	6	14	7	17	7	17	-	-	11	25	-	-	11	25	-	-
800	3	7	4	9	5	11	5	11	6	14	6	14	7	17	7	17	-	-	11	25	-	-	11	25	-	-
850	3	7	4	9	5	11	5	11	6	14	6	14	9	21	9	21	-	-	11	25	-	-	14	32	-	-
900	4	9	4	9	5	11	5	11	6	14	6	14	9	21	9	21	-	-	11	25	-	-	14	32	-	-
950	4	9	4	9	5	11	6	14	6	14	6	14	9	21	9	21	-	-	11	25	-	-	14	32	-	-
1000	4	9	5	11	5	11	6	14	6	14	6	14	9	21	9	21	-	-	11	25	-	-	14	32	-	-
1060	4	9	5	11	6	14	6	14	7	17	7	17	9	21	11	25	-	-	-	-	-	-	-	-	-	-
1120	4	9	5	11	6	14	6	14	7	17	7	17	11	25	11	25	-	-	-	-	-	-	-	-	-	-
1180	4	9	5	11	6	14	6	14	7	17	7	17	11	25	11	25	-	-	-	-	-	-	-	-	-	-
1250	5	11	5	11	6	14	6	14	7	17	7	17	11	25	11	25	-	-	-	-	-	-	-	-	-	-
1320	5	11	5	11	6	14	6	14	9	21	9	21	11	25	11	25	-	-	-	-	-	-	-	-	-	-
1400	5	11	6	14	7	17	7	17	9	21	9	21	14	32	14	32	-	-	-	-	-	-	-	-	-	-
1500	5	11	6	14	7	17	7	17	9	21	9	21	14	32	14	32	-	-	-	-	-	-	-	-	-	-
1600	6	14	6	14	7	17	7	17	9	21	9	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1700	6	14	6	14	7	17	7	17	11	25	11	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1800	6	14	7	17	9	21	9	21	11	25	11	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1900	6	14	7	17	9	21	9	21	11	25	11	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	7	17	7	17	9	21	9	21	11	25	11	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2120	7	17	7	17	9	21	9	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2240	7	17	7	17	9	21	9	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2360	7	17	7	17	9	21	9	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2500	7	17	7	17	11	25	11	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1) Not necessarily applicable to a) the groove side of bearing races with snap ring groove
b) the flangeless side of thin cylindrical roller bearing races
c) the non-thrust side of angular contact bearing races
d) both faces of double row tapered bore bearings

2) Minimum chamfer indicates maximum shaft fillet radius

3) Maximum chamfer indicates minimum shaft shoulder height

TABLE 2,2

NOMINAL CHAMFER DIMENSIONS
AND THEIR CORRESPONDING TOLERANCES

Nominal Chamfer r mm	r_{min}	r_{max}	$r_{max} - r_{min}$
0,2	0,1	0,3	0,2
0,25	0,15	0,4	0,25
0,3	0,2	0,5	0,3
0,4	0,2	0,6	0,4
0,5	0,3	0,8	0,5
0,5	0,3	1	0,7
1	0,6	1,5	0,9
1,5	1	2,2	1,2
2	1	2,7	1,7
2,5	1,5	3,5	2
3	2	4	2
3,5	2	4,5	2,5
4	2,5	5,5	3
5	3	7	4
6	4	9	5
8	5	11	6
10	6	14	8
12	7	17	10
15	9	21	12
18	11	25	14
22	14	32	18

3. Extension of the General Plan

ISO TC 4 (Secretariat 13) 36, January 1952. Chapter II, Section 1, Table 1,3 (pages 6 and 7)

TC Resolution 20 (9 New York 1952)

An extension of the general plan up to the desired bore sizes has to be made in accordance with the general rules. The bore series has to follow the number series R 40.

The outer diameters in the different diameter series have to follow the calculated values as closely as possible without the introduction of too many new or odd diameters. As far as possible they have been taken from the number series R 80. The diameters 1580 and 1660 have been taken as they are used already in the accepted plan. The diameters 1780, 2780, 2850, 3040 and 3200 have been taken in order to satisfy the desired continuity of the plan.

The widths have been taken from the number series R 80 with the exception of 660, 865 and 880, which have been necessary in order to avoid substantial deviations from the calculated values and to preserve the continuity of the plan.

Sweden proposes the plan according to the following table 3,1.

TABLE 3.1

EXTENSION OF THE GENERAL PLAN FOR BOUNDARY DIMENSIONS OF RADIAL BEARINGS

(except tapered roller bearings)

Dimensions in mm

d	Diameter Series 8								Diameter Series 9								Diameter Series 0							
	D	Dimension Series							D	Dimension Series							D	Dimension Series						
		08	18	28	38	48	58	68		09	19	29	39	49	59	69		00	10	20	30	40	50	60
		B								B								B						
1120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1180	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1250	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1750	160	218	290	375	500	670	900
1320	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1850	170	230	300	400	530	710	950
1400	-	-	-	-	-	-	-	-	1820	136	185	243	315	425	560	750	1950	175	243	315	412	545	750	1000
1500	1820	103	140	185	243	315	438	580	1950	145	195	258	335	450	600	800	2120	200	272	355	462	615	825	1120
1600	1950	112	155	200	265	345	475	630	2060	150	200	265	345	462	615	825	2240	206	280	365	475	630	850	1150
1700	2060	115	160	206	272	355	488	650	2180	155	212	280	355	475	650	875	2360	212	290	375	500	650	900	1180
1800	2180	122	165	218	290	375	515	690	2300	160	218	290	375	500	670	900	2500	224	308	400	530	690	950	1250
1900	2300	128	175	230	300	400	545	730	2430	170	230	308	400	530	710	950	2650	243	325	425	560	750	1000	1320
2000	2430	136	190	250	325	425	580	775	2580	185	258	335	438	580	775	1030	2780	250	345	450	580	775	1060	1400
2120	2580	145	200	265	345	462	615	825	2720	190	265	345	450	600	800	1090	-	-	-	-	-	-	-	-
2240	2720	150	212	272	355	475	650	865	2900	212	290	375	500	650	875	1180	-	-	-	-	-	-	-	-
2360	2850	155	218	280	365	488	660	880	3040	218	300	388	515	670	925	1220	-	-	-	-	-	-	-	-
2500	3000	160	224	290	375	500	670	900	3200	224	308	400	530	690	950	1250	-	-	-	-	-	-	-	-

(cont.)

TABLE 3.1

EXTENSION OF THE GENERAL PLAN FOR BOUNDARY DIMENSIONS OF RADIAL BEARINGS

(except tapered roller bearings)

Dimensions in mm

d	Diameter Series 1						Diameter Series 2							Diameter Series 3					
	D	Dimension Series					D	Dimension Series						D	Dimension Series				
		01	11	21	31	41		82	02	12	22	32	42		83	03	13	23	33
		B						B							B				
800	-	-	-	-	-	-	-	-	-	-	-	-	-	1600	-	258	355	462	600
850	-	-	-	-	-	-	-	-	-	-	-	-	-	1700	-	272	375	488	630
900	-	-	-	-	-	-	1580	-	218	300	388	515	670	1780	-	280	388	500	650
950	-	-	-	-	-	-	1660	-	230	315	412	530	710	1850	-	290	400	515	670
1000	-	-	-	-	-	-	1750	-	243	330	425	560	750	1950	-	300	412	545	710
1060	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1120	1750	200	280	365	475	630	-	-	-	-	-	-	-	-	-	-	-	-	-
1180	1850	212	290	388	500	670	-	-	-	-	-	-	-	-	-	-	-	-	-
1250	1950	224	308	400	530	710	-	-	-	-	-	-	-	-	-	-	-	-	-
1320	2060	236	325	425	560	750	-	-	-	-	-	-	-	-	-	-	-	-	-
1400	2180	250	345	450	580	775	-	-	-	-	-	-	-	-	-	-	-	-	-
1500	2300	258	355	462	600	800	-	-	-	-	-	-	-	-	-	-	-	-	-

4. Calculation of Load Ratings

ISO TC 4 (Secretariat 13) 36, January 1952, Chapter II, Section 3 (pages 13 to 15)

TC Resolution 26 (15 New York 1952)

Sweden proposes the following presentation of the calculation. A separate quality factor f has been introduced to make it possible for the different manufacturers to consider their specific level and variation with time of material and manufacturing quality.

Load carrying capacity and life of radial ball bearings

Calculation of basic load rating, rating life and equivalent load

1. The magnitude of the basic load rating, C, for radial and angular contact ball bearings with balls not larger than 25,4 mm or 1 inch in diameter, is found from the formula

$$C = f_c \, (i \cos \alpha)^{0,7} \, Z^{2/3} \, D^{1,8}$$

where

i = the number of rows of balls in any one bearing

α = the nominal angle of contact = the nominal angle between the line of action of the ball load and a plane perpendicular to the bearing axis

Z = the number of balls per row

D = the ball diameter

the factor f_c depends on the rolling contact fatigue strength factor f of the material used. The highest value of the factor f found for hardened steel by any manufacturer up to the year 1952 is f = 10, if kg and mm units are used and f = 7450 if lb. and inch units are used. The values of $\frac{f_c}{f}$ for different types of ball bearings, as commonly designed, are given in table 4,1.

TABLE 4,1

$\frac{D \cos \alpha}{d_m}$	$\frac{f_c}{f}$			
	Single row radial [1] and single and double row angular contact groove ball bearings	Double row radial groove ball bearings	Selfaligning ball bearings	"Magneto" type ball bearings
0,05	0,477	0,453	0,176	0,165
0,06	0,501	0,476	0,189	0,177
0,07	0,522	0,495	0,292	0,189
0,08	0,540	0,512	0,214	0,199
0,09	0,555	0,526	0,226	0,210
0,10	0,567	0,539	0,238	0,219
0,12	0.585	0,555	0,261	0,239
0,14	0,598	0,568	0,282	0,258
0,16	0,607	0,576	0,303	0,276
0,18	0,611	0,580	0,323	0,294
0,20	0,612	0,581	0,342	0,311
0,22	0,609	0,578	0,359	0,327
0,24	0,603	0,572	0,375	0,343
0,26	0,594	0,564	0,389	0,358
0,28	0,583	0,554	0,401	0,372
0,30	0,571	0,542	0,410	0,386
0,32	0,558	0,530	0,417	0,397
0,34	0,543	0,515	0,421	0,406
0,36	0,527	0,500	0,422	0,412
0,38	0,510	0,484	0,419	0,415
0,40	0,492	0,467	0,410	0,417

1) When calculating the basic load rating for single row ball bearings in duplex mountings, the bearings are to be considered as double row bearings.

2. The magnitude of the rating life, L, is found for ball bearings, except filling notch bearings, from the formula

$$L = \left(\frac{C}{P}\right)^3 \text{ million revs}$$

where P is the equivalent load.

3. The magnitude of the equivalent load, P, is found for radial and angular contact ball bearings of conventional types, except filling notch bearings, under combined constant radial and constant thrust loads, from the formula

$$P = XF_r + YF_a$$

where

X = a radial factor
F_r = the radial load
Y = a thrust factor
F_a = the thrust load

Values of X and Y are given in table 4,2.

TABLE 4,2

$P = XF_r + YF_a$		Single Row Bearings		Double Row Bearings 3)				e
		$\frac{F_a}{F_r} > e$ 1)		$\frac{F_a}{F_r} \leq e$		$\frac{F_a}{F_r} > e$		
		X	Y	X	Y	X	Y	
Selfaligning ball bearings		0,4	0,4 cot α	1	0,42 cot α	0,65	0,65 cot α	1,5 tg α
Radial groove ball bearings, except filling notch bearings, α = 0	$\frac{F_a}{D^2 \sum Z}$ kg, mm							
	0,05	70	0,35	2	1	0	0,35	2	0,32
	0,15	200	0,34	1,6	1	0	0,34	1,6	0,41
	0,50	700	0,31	1,2	1	0	0,31	1,2	0,57
2) Angular contact ball bearings	α = 20°		0,31	1,04	1	0,94	0,5	1,69	0,67
	α = 25°		0,29	0,89	1	0,78	0,47	1,45	0,8
	α = 30°		0,27	0,76	1	0,65	0,44	1,24	0,96
	α = 35°		0,25	0,66	1	0,55	0,41	1,07	1,14
	α = 40°		0,23	0,57	1	0,46	0,37	0,93	1,35
Magneto type ball bearings			0,5	2,5	-	-	-	-	0,2

1) For $\frac{F_a}{F_r} \leq e$: X = 1 and Y = 0.

2) For angular contact ball bearings mounted "Face-to-Face" or "Back-to-Back" the same values of X and Y are used as those for double row angular contact ball bearings. For angular contact ball bearings, mounted in "tandem" the same values of X and Y are used as those given for single row angular contact ball bearings.

3) Double row bearings are presumed to be symmetrical.

5. Extension of Tolerance Tables for large Bearings

ISO TC 4 (Secretariat 13) 36, January 1952, Chapter II, Section 2 (pages 8 to 10)

TC Resolution 42 (31 New York 1952)

TC Resolution 37 (26 New York 1952)

The extension of grade 1 tolerances to cover the larger bearings proposed under section 3 above may be made applying the same rules as used for the smaller bearings. It must however be left open whether the bore and outer diameter tolerances are applicable as the possibility to measure very large diameters accurately is limited at the present time.

The following tables 5,1 and 5,2 contain the tolerances proposed by Sweden. For the sake of completeness the footnotes proposed by other member bodies are included.

TABLE 5,1

GRADE 1 TOLERANCES OF RADIAL BEARINGS

Tolerances in 0.001 mm

Nominal Bore d min		Inner Ring						Width Tolerance Limits	
		Bore Tolerance Limits				Radial Run-out	Width Variation	Inner and Outer Rings excl. Tapered Roller Bearings	
		d_m (KB)		d_{min} 1)	d_{max} 1)				
Over	Incl.	Low	High			Max	Max	High	Low
		- 8	0	-10	+ 2	10	15	0	- 120
(10)	18	- 8	0	-11	+ 3	10	20	0	- 120
(18)	30	- 10	0	-13	+ 3	13	20	0	- 120
(30)	50	- 12	0	-15	+ 3	15	20	0	- 120
(50)	80	- 15	0	-19	+ 4	20	25	0	- 150
(80)	120	- 20	0	-25	+ 5	25	25	0	- 200
(120)	180	- 25	0	-31	+ 6	30	30	0	- 250
(180)	250	- 30	0	-38	+ 8	40	30	0	- 300
(250)	315	- 35	0	-44	+ 9	50	35	0	- 350
(315)	400	- 40	0	-50	+10	60	40	0	- 400
(400)	500	- 45	0	-57	+12	65	-	0	- 450
(500)	630	- 50	0	-	-	70	-	0	- 500
(630)	800	- 75	0	-	-	-	-	0	- 750
(800)	1000	-100	0	-	-	-	-	0	-1000
(1000)	1250	-125	0	-	-	-	-	0	-1250
(1250)	1600	-160	0	-	-	-	-	0	-1600
(1600)	2000	-200	0	-	-	-	-	0	-2000
(2000)	2500	-250	0	-	-	-	-	0	-2500

Values not shown, or where not applicable, have yet to be determined.

1) Applies to diameter series 0, 2, 3 and 4 only: in diameter series 0 up to and incl. 40 mm.; in diameter series 2 up to and incl. 180 mm.

TABLE 5,2

GRADE 1 TOLERANCES OF RADIAL BEARINGS

Tolerances in 0.001 mm

Nominal Outer Diameter D mm		OUTER RING				
		Outer Diameter Tolerance Limits				Radial Run Out
		D_m (hB)		D_{max} 1)	D_{min} 1)	
Over	Incl.	High	Low			Max
	18	0	- 8	+ 2	-10	15
(18)	30	0	- 9	+ 2	-11	15
(30)	50	0	- 11	+ 3	-14	20
(50)	80	0	- 13	+ 4	-17	25
(80)	120	0	- 15	+ 5	-20	35
(120)	150	0	- 18	+ 6	-24	40
(150)	180	0	- 25	+ 7	-32	45
(180)	250	0	- 30	+ 8	-38	50
(250)	315	0	- 35	+ 9	-44	60
(315)	400	0	- 40	+10	-50	70
(400)	500	0	- 45	+12	-57	80
(500)	630	0	- 50	+14	-64	100
(630)	800	0	- 75	-	-	-
(800)	1000	0	-100	-	-	-
(1000)	1250	0	-125	-	-	-
(1250)	1600	0	-160	-	-	-
(1600)	2000	0	-200	-	-	-
(2000)	2500	0	-250	-	-	-
(2500)	3150	0	-315	-	-	-
(3150)	4000	0	-400	-	-	-

Values not shown, or where not applicable, have yet to be determined.

1) Applies to diameter series 0, 2, 3 and 4 only: in diameter series 0 up to and incl. 80 mm.; in diameter series 2 up to and incl. 315 mm.

6. Dimensions of Bearings with Snap Ring Groove

ISO TC 4 SC 1 (Sweden 11) 33, January 1952, Section 2 (pages 2 to 4)
SC 1 Resolution 32 (2 New York 1952)

Sweden proposes the tables regarding the bearings with snap ring groove and the snap rings to be modified in accordance with the following tables 6,1 and 6,2.

This proposal satisfies the wishes expressed in the SC 1 Resolution with the following minor exceptions:

b_{min} for D = 90 - 115 has been rounded off from 2,6924 to 2,7 mm

b_{max} for the same outer diameters has been rounded off from 2,9924 to 3 mm

$D_{2\ max}$ has been taken as $D_{1\ max} + 2\ e_{max}$ and rounded off upwards to the nearest even tenth of a millimeter

g has been left unchanged as the values are indicated as approximate and therefore may be given in even millimeters.

TABLE 6,1
BEARINGS WITH SNAP RING GROOVE
Dimensions in mm

Outer Diameter D	Diameter D_1		Distance a				Groove Width b		Chamfer r_o
			Diameter Series 0		Diameter Ser. 2,3, & 4				
	$D_{1\ max}$	$D_{1\ min}$	a_{max}	a_{min}	a_{max}	a_{min}	b_{min}	b_{max}	$r_{o.\ max}$
30	28,17	27,91	-	-	2,06	1,9	1,35	1,65	0,4
32	30,15	29,9	2,06	1,9	2,06	1,9	1,35	1,65	0,4
35	33,17	32,92	2,06	1,9	2,06	1,9	1,35	1,65	0,4
37	34,77	34,52	-	-	2,06	1,9	1,35	1,65	0,4
40	38,1	37,85	-	-	2,06	1,9	1,35	1,65	0,4
42	39,75	39,5	2,06	1,9	2,06	1,9	1,35	1,65	0,4
47	44,6	44,35	2,06	1,9	2,46	2,31	1,35	1,65	0,4
52	49,73	49,48	-	-	2,46	2,31	1,35	1,65	0,4
55	52,6	52,35	2,08	1,88	-	-	1,35	1,65	0,6
62	59,61	59,11	2,08	1,88	3,28	3,07	1,9	2,2	0,6
68	64,82	64,31	2,49	2,29	-	-	1,9	2,2	0,6
72	68,81	68,3	-	-	3,28	3,07	1,9	2,2	0,6
75	71,83	71,32	2,49	2,29	-	-	1,9	2,2	0,6
80	76,81	76,3	2,49	2,29	3,28	3,07	1,9	2,2	0,6
85	81,81	81,31	-	-	3,28	3,07	1,9	2,2	0,6
90	86,79	86,28	2,87	2,67	3,28	3,07	2,7	3	0,6
95	91,82	91,31	2,87	2,67	-	-	2,7	3	0,6
100	96,8	96,29	2,87	2,67	3,28	3,07	2,7	3	0,6
110	106,81	106,3	2,87	2,67	3,28	3,07	2,7	3	0,6
115	111,81	111,3	2,87	2,67	-	-	2,7	3	0,6
120	115,21	114,71	-	-	4,06	3,86	3,1	3,4	0,6
125	120,22	119,71	2,87	2,67	4,06	3,86	3,1	3,4	0,6
130	125,22	124,71	2,87	2,67	4,06	3,86	3,1	3,4	0,6
140	135,23	134,72	3,71	3,45	4,9	4,65	3,1	3,4	0,6
145	140,23	139,73	3,71	3,45	-	-	3,1	3,4	0,6
150	145,24	144,73	3,71	3,45	4,9	4,65	3,1	3,4	0,6
160	155,22	154,71	3,71	3,45	4,9	4,65	3,1	3,4	0,6
170	163,65	163,14	3,71	3,45	5,69	5,44	3,5	3,8	0,6
180	173,66	173,15	3,71	3,45	5,69	5,44	3,5	3,8	0,6
190	183,64	183,13	-	-	-	-	-	-	0,6
200	193,65	193,14	5,69	5,44	5,69	5,44	3,5	3,8	0,6

Chamfer r_1 at all points of bearing circumference to clear 0,5 mm fillet radius.

TABLE 6,2

SNAP RINGS

Dimensions in mm.

Bearing Outer Diameter D	Diameter[1] D_2	Height of Snap Ring Section, e		Width of Snap Ring Section , f		g[1]
	D_2 max	e_{max}	e_{min}	f_{max}	f_{min}	
30	34,7	3,25	3,1	1,12	1,02	3
32	36,7	3,25	3,1	1,12	1,02	3
35	39,7	3,25	3,1	1,12	1,02	3
37	41,3	3,25	3,1	1,12	1,02	3
40	44,6	3,25	3,1	1,12	1,02	3
42	46,3	3,25	3,1	1,12	1,02	3
47	52,7	4,04	3,89	1,12	1,02	4
52	57,9	4,04	3,89	1,12	1,02	4
55	60,7	4,04	3,89	1,12	1,02	4
62	67,7	4,04	3,89	1,7	1,6	4
68	74,6	4,85	4,7	1,7	1,6	5
72	78,6	4,85	4,7	1,7	1,6	5
75	81,6	4,85	4,7	1,7	1,6	5
80	86,6	4,85	4,7	1,7	1,6	5
85	91,6	4,85	4,7	1,7	1,6	5
90	96,5	4,85	4,7	2,46	2,36	5
95	101,6	4,85	4,7	2,46	2,36	5
100	106,5	4,85	4,7	2,46	2,36	5
110	116,6	4,85	4,7	2,46	2,36	5
115	121,6	4,85	4,7	2,46	2,36	5
120	129,7	7,21	7,06	2,82	2,72	7
125	134,7	7,21	7,06	2,82	2,72	7
130	139,7	7,21	7,06	2,82	2,72	7
140	149,7	7,21	7,06	2,82	2,72	7
145	154,7	7,21	7,06	2,82	2,72	7
150	159,7	7,21	7,06	2,82	2,72	7
160	169,7	7,21	7,06	2,82	2,72	7
170	182,9	9,6	9,45	3,1	3	10
180	192,9	9,6	9,45	3,1	3	10
190	202,9	9,6	9,45	3,1	3	10
200	212,9	9,6	9,45	3,1	3	10

1) The dimensions given for D_2 and g apply to mounted snap rings. The rings must fit in the grooves without radial slackness and are therefore somewhat expanded in mounted condition.

7. Grade 7 Tolerances of Radial Bearings

ISO TC 4 SC 1 (Sweden 11) 33, January 1952, Section 7 (pages 12 to 14)
SC 1 Resolution 38 (8 New York 1952)

Sweden proposes the grade 7 tolerances shown in the following tables 7,1 and 7,2.

TABLE 7,1

TOLERANCES OF RADIAL BEARINGS

Grade 7

Tolerances in 0,001 mm.

Nominal Bore d mm		INNER RING						
		Bore Tolerances		Radial Run Out	Groove Parallelism with Side Run Out	Width Tolerances		Width Variation
Over	Incl.	d_{min}	d_{max}	max	max	B_{max}	B_{min}	max
(3)	10	- 4	0	3	3	0	- 50	3
(10)	18	- 4	0	3	3	0	- 50	3
(18)	30	- 5	0	4	4	0	- 50	3
(30)	50	- 5	0	4	4	0	- 50	3
(50)	80	- 6	0	4	5	0	- 60	4
(80)	120	- 7	0	5	6	0	- 70	4
(120)	180	- 8	0	6	7	0	- 80	5
(180)	250	-10	0	7	8	0	-100	5

TABLE 7,2

TOLERANCES OF RADIAL BEARINGS

Grade 7

Tolerances in 0,001 mm

Nominal Outer Diameter D mm		OUTER RING				
		Outer Diameter Tolerances		Radial Run Out	Groove Parallelism with Side Run Out	Width Variation
Over	Incl.	D_{max}	D_{min}	max	max	max
(6)	18	0	- 5	5	5	3
(18)	30	0	- 5	5	5	3
(30)	50	0	- 5	5	5	3
(50)	80	0	- 6	6	6	4
(80)	120	0	- 8	7	7	5
(120)	150	0	-10	8	8	6
(150)	180	0	-10	8	8	6
(180)	250	0	-12	10	10	7
(250)	315	0	-14	12	12	8
(315)	400	0	-16	14	14	8

Width tolerances equal to width tolerances of inner rings

8. Boundary Dimensions of Mounting Sleeves

The following proposals are made.

ADAPTER SLEEVES

Symbols

d = Bearing bore, small diameter
d_1 = Sleeve bore
L = Sleeve length
B = Nut width
D = Nut outer diameter

The proposed dimensions of adapter sleeves with taper 1:12 are shown in table 8,1. The nut width does not include the space occupied by the locking device.

TABLE 8,1

Bearing Bore d mm	d_1	B	D	L			
10	7	4	18	16	21	24	-
12	9	4	22	17	21	24	-
15	12	5	25	19	22	25	-
17	14	5	28	20	24	27	-
20	17	6	32	24	27	31	-
25	20	7	38	26	29	35	-
30	25	7	45	27	31	38	-
35	30	8	52	29	35	43	-
40	35	9	58	31	36	46	-
45	40	10	65	33	39	50	-
50	45	11	70	35	42	55	-
55	50	11	75	37	44	59	-
60	55	11	80	38	47	62	-
65	60	12	85	40	50	65	-
70	60	12	92	41	52	68	-
75	65	13	98	43	55	73	-
80	70	15	105	46	59	78	-
85	75	16	110	50	62	82	-
90	80	16	120	52	65	86	-
95	85	17	125	55	68	90	-
100	90	18	130	58	71	97	-
105	95	18	140	60	74	101	-
110	100	18	145	63	77	81	105
			D	L	D	L	
120	110	20	145	72	155	88	112
130	115	21	155	79	165	92	121
140	125	22	165	82	180	97	131
150	135	23	180	87	195	111	139
160	140	25	190	93	210	119	147
170	150	26	200	101	220	123	154
180	160	26	210	109	230	131	161
190	170	28	220	112	240	141	169
200	180	29	240	120	250	150	176
220	200	30	260	128	280	158	183
240	220	33	290	133	300	169	196
260	240	35	310	147	330	187	210
280	260	38	330	152	350	192	221
300	280	40	360	166	380	208	240
320	300	42	380	171	400	226	258

These sleeves may be used for bearings in different dimension series as shown in Tables 8,2 to 8,9 by the sleeve length.

TABLE 8,2

Bearing Bore d mm	Dimension Series								
	30	31	02	12	22	32	03	13	23
10	-	-	16	-	21	-	21	-	24
12	-	-	17	-	21	-	21	-	24
15	-	-	19	-	22	-	22	-	25
17	-	-	20	-	24	-	24	-	27
20	-	-	24	-	28	-	28	-	31
25	-	-	26	-	29	-	29	-	35
30	-	-	27	-	31	-	31	-	38
35	-	-	29	-	35	-	35	-	43
40	-	-	31	-	36	-	36	-	46
45	-	-	33	-	39	-	39	-	50
50	-	-	35	-	42	-	42	-	55
55	-	-	37	-	45	-	45	-	59
60	-	-	38	-	47	-	47	-	62
65	-	-	40	-	50	-	50	-	65
70	-	-	41	-	52	-	52	-	68
75	-	-	43	-	55	-	55	-	73
80	-	-	46	-	59	-	59	-	78
85	-	-	50	-	63	-	63	-	82
90	-	-	52	-	65	86	65	-	86
95	-	-	55	-	68	90	68	-	90
100	-	-	58	-	71	97	71	-	97
105	-	-	60	-	74	101	74	-	101
110	-	81	63	-	77	105	77	-	105
120	72	88	72	72	88	112	88	-	112
130	79	92	79	79	92	121	92	-	121
140	82	97	82	82	97	131	97	-	131
150	87	111	87	87	111	139	111	111	139
160	93	119	93	93	119	147	119	119	147
170	101	123	101	101	123	154	123	123	154
180	109	131	109	109	131	161	131	131	161
190	112	141	112	112	141	169	141	141	169
200	120	150	120	120	150	176	150	150	176
220	128	158	-	-	158	183	-	-	183
240	133	169	-	-	169	196	-	-	196
260	147	187	-	-	187	210	-	-	210
280	152	192	-	-	192	221	-	-	221
300	166	208	-	-	208	240	-	-	240
320	171	226	-	-	226	258	-	-	258

WITHDRAWAL SLEEVES

Symbols

d = Bearing bore, small diameter

d_1 = Sleeve bore

L = Nominal overall length of sleeve and bearing

The proposed boundary dimensions of withdrawal sleeves with taper 1:12 are shown in table 8,3.

TABLE 8,3

d	d_1	L				Thread	d	d_1	L				Thread
40	35	32	43	-	-	M 45 x 1,5	190	180	117	131	152	167	Tr 210 x 4
45	40	34	47	-	-	M 50 x 1,5	200	190	108	-	-	-	Tr 215 x 4
50	45	38	53	-	-	M 55 x 2	200	190	123	140	160	177	TR 220 x 4
55	50	40	57	-	-	M 60 x 2	220	200	117	-	-	-	Tr 235 x 4
60	55	43	61	-	-	M 65 x 2	220	200	136	151	185	-	Tr 240 x 4
65	60	45	64	-	-	M 75 x 2	240	220	121	150	161	197	Tr 260 x 4
70	65	47	68	-	-	M 80 x 2	260	240	135	-	-	-	Tr 280 x 4
75	70	49	72	-	-	M 85 x 2	260	240	161	179	213	-	Tr 290 x 4
80	75	52	75	-	-	M 90 x 2	280	260	139	-	-	-	Tr 300 x 4
85	80	55	78	-	-	M 95 x 2	280	260	163	183	220	-	Tr 310 x 5
90	85	57	67	83	-	M 100 x 2	300	280	153	-	-	-	Tr 320 x 5
95	90	60	71	88	-	M 105 x 2	300	280	178	200	236	-	Tr 330 x 5
100	95	62	77	94	-	M 110 x 2	320	300	157	-	-	-	Tr 345 x 5
105	100	65	82	-	-	M 115 x 2	320	300	190	217	254	-	Tr 350 x 5
105	100	98	-	-	-	M 120 x 2	340	320	171	-	-	-	Tr 365 x 5
110	105	67	72	-	-	M 120 x 2	340	320	234	-	-	-	Tr 370 x 5
110	105	86	102	-	-	M 125 x 2	360	340	176	-	-	-	Tr 385 x 5
120	115	64	73	79	-	M 130 x 2	360	340	238	-	-	-	Tr 400 x 5
120	115	94	109	-	-	M 135 x 2	380	360	178	-	-	-	Tr 410 x 5
130	125	71	78	82	-	M 140 x 2	380	360	242	-	-	-	Tr 420 x 5
130	125	100	118	-	-	M 145 x 2	400	380	193	-	-	-	Tr 430 x 5
140	135	73	82	88		M 150 x 2	400	380	250	-	-	-	Tr 440 x 5
140	135	109	130	-	-	M 155 x 3	420	400	196	-	-	-	Tr 450 x 5
150	145	77	-	-	-	M 160 x 3	420	400	276	-	-	-	Tr 460 x 5
150	145	87	101	119	138	M 165 x 3	440	420	205	-	-	-	Tr 470 x 5
160	150	82	-	-	-	M 170 x 3	440	420	281	-	-	-	Tr 480 x 5
160	150	91	108	130	146	M 180 x 3	460	440	213	-	-	-	Tr 490 x 5
170	160	90	-	-	-	M 180 x 3	460	440	296	-	-	-	Tr 510 x 6
170	160	96	110	140	152	M 190 x 3	480	460	217	-	-	-	Tr 520 x 6
180	170	98	-	-	-	M 190 x 3	480	460	307	-	-	-	Tr 530 x 6
180	170	110	122	143	160	M 200 x 3	500	480	221	-	-	-	Tr 540 x 6
190	180	100	-	-	-	Tr 205 x 4	500	480	325	-	-	-	Tr 550 x 6

These sleeves may be used for bearings in different dimension series as shown in table 8,4, in which the sleeve is characterized by the nominal overall length of sleeve and bearing.

TABLE 8,4

Bearing Bore d mm	Dimension Series						
	30	31	22	32	03	13	23
40	-	-	32	-	32	-	43
45	-	-	34	-	34	-	47
50	-	-	38	-	38	-	53
55	-	-	40	-	40	-	57
60	-	-	43	-	43	-	61
65	-	-	45	-	45	-	64
70	-	-	47	-	47	-	68
75	-	-	49	-	49	-	72
80	-	-	52	-	52	-	75
85	-	-	55	-	55	-	78
90	-	-	57	67	57	-	83
95	-	-	60	71	60	-	88
100	-	-	62	77	62	-	94
105	-	-	65	82	65	-	98
110	-	72	72	86	67	-	102
120	64	79	79	94	73	-	109
130	71	82	82	100	78	-	118
140	73	88	88	109	82	-	130
150	77	101	101	119	87	87	138
160	82	108	108	130	91	91	146
170	90	110	110	140	96	96	152
180	98	122	110	143	-	-	160
190	100	131	117	152	-	-	167
200	108	140	123	160	-	-	177
220	117	151	136	185	-	-	185
240	121	161	150	197	-	-	197
260	135	179	161	213	-	-	213
280	139	183	163	220	-	-	220
300	153	200	178	236	-	-	-
320	157	217	190	254	-	-	-
340	171	234	-	-	-	-	-
360	176	238	-	-	-	-	-
380	178	242	-	-	-	-	-
400	193	250	-	-	-	-	-
420	196	276	-	-	-	-	-
440	205	281	-	-	-	-	-
460	213	296	-	-	-	-	-
480	217	307	-	-	-	-	-
500	221	325	-	-	-	-	-